SPRAY APPLIED CELLULOSE INSULATION FOR WALLS

Alberta
MUNICIPAL AFFAIRS
Innovative Housing Grants Program

SPRAY APPLIED CELLULOSE INSULATION FOR WALLS

March, 1988

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The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

With funding provided by
Alberta Municipal Affairs

ISBN: 0-88654-210-3

FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

The Program offers assistance to builders, developers, consulting firms, professionals, industry groups, building products manufacturers, municipal governments, educational institutions, non-profit groups and individuals. At this time, priority areas for investigation include building design, construction technology, energy conservation, site and subdivision design, site servicing technology, residential building product development or improvement and information technology.

As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

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EXECUTIVE SUMMARY

Can-Cell Industries Inc. has been producing WEATHERSHIELD cellulose insulation at its Edmonton and Calgary plants for fifteen years. This material has traditionally been used as an attic loose-fill where its void free, blanket coverage has been recognized as an effective means of reducing heat loss through air leakage. The objective of this study was to develop a method for extending use of this material to exterior wall systems where air leakage is known to be a difficult problem to control using conventional methods.

Work undertaken involved developing a spray nozzle and application technique which enabled spraying a moist mixture of insulation and adhesive into open stud cavities so as to form in place a free standing, full fitting blanket of insulation. Further laboratory work was done to establish actual moisture content of the installed material and the rate at which the moisture would dissipate from an enclosed wall cavity.

Several field installations were undertaken successfully. One installation is currently being monitored for air leakage and moisture dissipation by an engineering firm under a contract from CMHC.

It has been determined that the installation procedure is practical, that air leakage is substantially reduced, and that builders aiming at R2000 criteria can use this system cost effectively.

1.0 INTRODUCTION

Houses are insulated for two main reasons, to conserve energy and to provide comfort. Recently, air infiltration into and through the building envelope has received a great deal of research attention. Air infiltration into the living areas and also into the wall cavity must be considered.

Under windy conditions the building is subjected to both positive and negative air pressures. Ambient air is literally blown into the building through the windward wall envelope while heated air is sucked out through the lee wall. The extent that air leakage occurs is primarily dependent on the air tightness of a building envelope. Of importance also is the circulation of air within a wall cavity, which decreases the thermal resistance of the wall envelope and causes discomfort by lowering the temperature of the interior wall finish.

To stop air leakage through a wall membrane, it is necessary to provide a comprehensive air barrier all around. While careful workmanship in the installation of vapour barrier, caulking and sheathing can provide substantial air leakage resistance, added effectiveness can be gained by using an insulation that has good resistance to air movement. The most common type of insulation, fibreglass, has very little resistance to the movement of air and

often suffers further from poor fit around electrical installations, pipes and irregular cavities. Cellulose insulation has a fine grain structure that allows it to achieve densities that restrict air movement, yet still provide excellent thermal resistance values. Cellulose insulation is normally used as a loosefill material. If used in walls, conventional practise has been to inject the material into an enclosed cavity. This precludes its use in walls open on one side, which is the normal situation when a new house is ready for insulation. Furthermore, the building code currently prohibits the use of loosefill in the enclosed walls of new houses because it would not be possible to visually ascertain that wall cavities are free of voids. Although development work is being done on a solution to this problem which involves enclosing the interior surface with transparent poly, both labour and material costs are significantly increased. A method of spraying insulation has been developed to take advantage of the superior characteristics of cellulose, yet allow it to be installed in an open stud cavity. This method is called alternately sprayed cellulose or formed-in-place insulation. It involves spraying a wetted cellulose material containing a small amount of powdered adhesive into the open wall cavity. The material totally fills the space and in effect forms a dense blanket of insulation that prevents air movement and eliminates all the void problems of semi-rigid

material. Furthermore, as with batts, the completed installation can be inspected prior to the application of the interior wall surfaces.

The use of spray applied thermal insulation incorporating a liquid adhesive binder has a long and successful history, but has been restricted mainly to exposed surfaces. Use in enclosed wall cavities has not seen wide use in Canada mainly because it was considered more labour intensive, costly and messy than the traditional fibreglass batt method, and because the use of water and liquid adhesive was considered a handicap during freezing conditions. Use of the spray method, incorporating only dry adhesive, is gaining increased popularity with U.S. builders who report excellent air tightness results at costs only marginally higher than with fibreglass batts.

This project was undertaken to bring together all available technical information on the technique, to develop the methods in Alberta (i.e. technology transfer), then to demonstrate the application and obtain building standards approval. The report is organized into sections that follow in order of the development from initial literature searches through to final approvals.

2.0 TECHNICAL REQUIREMENTS

2.1 Installation Methods

Two methods of placing insulation in a wall cavity were explored. The first method, hereafter referred to as Method A, involved stapling a poly netting over the interior face of a stud wall and pneumatically injecting the moistened fibre into the stud cavity behind the mesh. Method B was similar except that moistened fibre was spray applied directly into the stud cavity with sufficient impact to form a free-standing mass in the cavity without the need for a restraining mesh as in Method A. Two different types of spray nozzle were used: the internal mix type for Method A; and the external mix type for Method B. Both procedures entail feeding the fibre from a conventional insulation application machine through a 2" pneumatic hose to a spray nozzle located at the application site.

2.2 Method A - Internal Mix Nozzle With Netting

The spray nozzle used with Method A is the internal mix type which is supplied with both water and compressed air in addition to the dry insulation. The nozzle design

causes the water and compressed air to form a fine mist which moistens the insulation prior to its emission from the nozzle. The moistened material is propelled from the nozzle through a 6 - 8' length of pneumatic hose which protrudes into the wall cavity through an opening in the mesh. A patent search of internal mix spray nozzles suitable for fibre application turned up two possibilities: (a) U.K. Patent Application GB 2-149-691A, June 19, 1985, and (b) U.S. Patent 4530468, July 23, 1985. See figure 2.2 below.

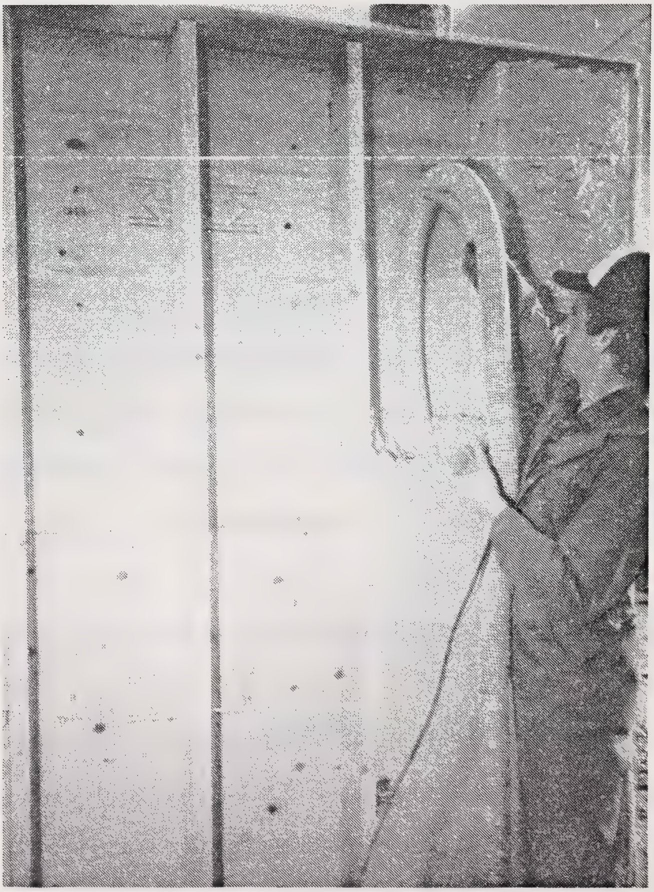


Figure 2.2 - Method A

2.2.1 U.K. Nozzle Patent - Internal Mix

The U.K. Patent (Appendix A) employed a principle of fluidics known as the Coanda Effect. This innovation offered to solve the problem of the moistened fibre impinging on the wall of the nozzle until it eventually plugs off the flow. A working model was constructed and tested, but proved incapable of producing an uninterrupted flow of moistened fibre through the extra piece of whip hose needed to inject material behind the mesh.

2.2.2 U.S. Nozzle Patent - Internal Mix

A nozzle as described in the U.S. Patent (Appendix B) was also obtained and tested quite extensively. This model proved more successful, particularly with non-absorbent glassfibre, but would not process cellulose fibre without eventually plugging off the whip hose. Although a skilled operator might achieve a significant rate of sustained production by careful co-ordination of water and fibre supplies, it was judged too unreliable for practical field use.

2.3 Method B - External Mix Nozzle- No Netting

Attention was next directed to the Method B technique which required the external mix type of nozzle. A patent search for external mix spray nozzles turned up a variety of rather conventional designs which were generally suitable. Canadian Patent 951597, March 15, 1975 (Appendix C) is typical. The external mix nozzle used with Method B was fed with dry fibre through a 2" (or larger) pneumatic hose and with water at about 200 psi pressure. Compressed air was not used. This nozzle was designed so that dry material was projected out of a central orifice and caused to pass through a spray pattern of water which emitted from a series of spray jets mounted concentric to the dry material orifice.

Figure 2.3
Method B

2.4 Comparison of Method A and Method B

Overspray, bounce back and fall-off with Method B did produce some waste. However, there was no plugging problem as the mixing was done externally to the nozzle, and the cost of the mesh was avoided. After careful evaluation it was concluded that Method B offered several advantages over Method A:

(a) External mixing avoided plugging problems.

(b) External mixing permitted operation with hydraulically atomizing spray jets, thereby avoiding the added cost and burden of a compressed air supply.

(c) Direct spray avoided the cost of netting.

(d) Direct spray had a "fail safe" aspect in that it had to be installed at the correct density, without voids or light spots, or the material would not form a self supporting mat; unlike Method B which could accommodate some deficiencies because of the restraining mesh.

2.5 Selected Method

In consideration of the above factors, further development work concentrated on the direct spray Method B. Significant aspects of this process are described in the following sections.

3.0 INSTALLATION PARAMETERS AND TECHNIQUES

3.1 Material Velocity

A key factor in spray forming a stable mass of insulation in a vertical stud cavity is the material flow velocity at the point of impact. Too little impact and the material becomes unstable and falls out of position, too high an impact and the material bounces off the substrate. Although it is difficult to mathematically quantify the optimum flow velocity in terms of blower pressure and fibre feed rate, a practical "rule of thumb" is to adjust both air and fibre so that material can be propelled horizontally from the hose end about 3' before deteriorating to a downward arc. Proper impact velocity is achieved when impact occurs at the point in the material stream which is just short of the downward arc. Impact velocity is therefore controlled first by adjustment of the machine and, second, by holding the hose end the proper distance from the impact point. The matter of hose distance is important because the fibrous matter undergoes a marked decrease in velocity from the point where it leaves the hose to the point where its trajectory tails off.

3.2 Water Rate

Once the proper flow of dry material has been established it is necessary to adjust the water supply accordingly. Too little moisture prevents the fibre from sticking in position, too much can result in making the insulation mass so heavy it will sag. Obviously, the optimum amount is the minimum which will permit the applicator to achieve a stable mass without excessive bounce back or fall out. Water flow rate is a function of pump pressure, hose size and length, and jet size and number. The above variables must be adjusted to achieve the desired rate. The net result should be a fibre/water ratio, by weight, of approximately 1:1. Our experience indicated, for example, that a pump pressure of 200 psi, connected to 100' of 3/8" I.D. hose, supplying a nozzle holding 4 jets with a .036" orifice, would deliver the amount of water spray to properly moisten insulation flowing at a rate of about 23 lbs. per minute.

3.3 Mat Density

Density of the fibre mat formed with cellulose material is not an important factor with regard to thermal performance. Unlike glassfibre insulations, cellulose

R-Value remains quite stable throughout the useable density range (See Figure 3.3). The optimum density was determined to be in the range of 3 pounds per cubic foot (PCF). Densities higher than 3 PCF were considered wasteful of material, while lower densities tended to produce problems of fallout, which were wasteful of both time and material.

March, 1988

THERMAL RESISTANCE VERSUS APPLIED BULK DENSITY
Blowing-type Insulation Comparison: Mineral Fiber vs. Cellulosic Fiber Insul.
(NRC data for Mineral Fiber, DYNATECH/NRC data for Cellulosic Fiber Insulation)

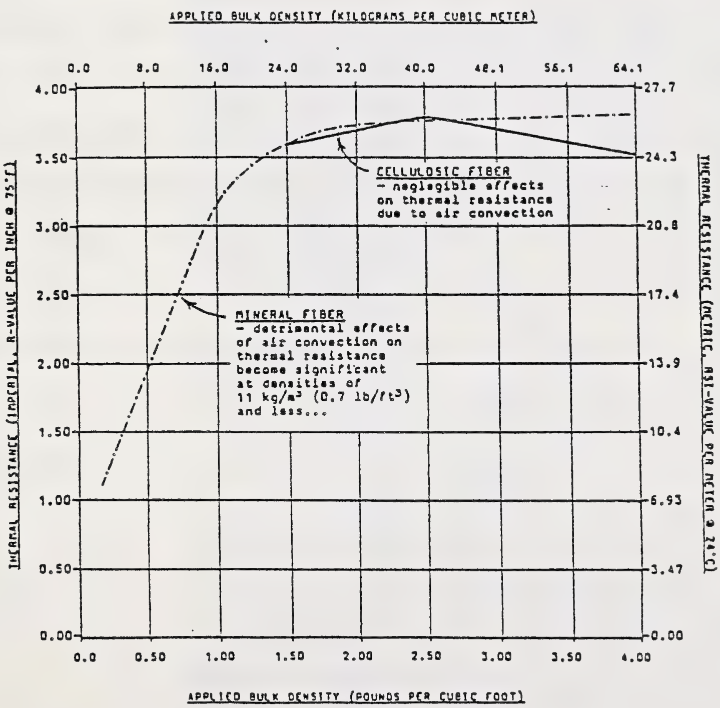


Figure 3.3 - Density vs R-Value

3.4 Material Waste

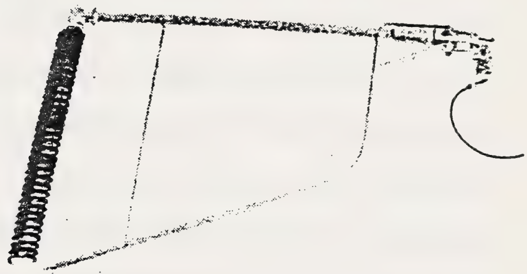
Waste with this system could be substantial unless the operator was sufficiently skilled to avoid fall-out, to avoid application of more than optimum density, and to avoid waste through overspraying. Waste through overspraying can result from putting material where it doesn't belong or putting it in place at a greater thickness than desired. In either case the excess material must be removed. Removal may be done by screeding with a piece of board or with a stud scrubber, which is a powered rotary brush (See figure 3.4). Virtually all of the waste may be utilized by manually placing it into the bottom of stud cavities as work progresses. This material may be lightly tamped into a void formed with an 18" strip of plywood temporarily held against the stud faces. Using this technique a skilled operator should be able to reduce waste to less than 3%.

WEATHERSHIELD PRODUCTS

CAN-CELL INDUSTRIES INC.

MANUFACTURER AND DISTRIBUTOR OF BUILDING MATERIALS AND HARDWARE PRODUCTS

INSULATION SCRUBBER



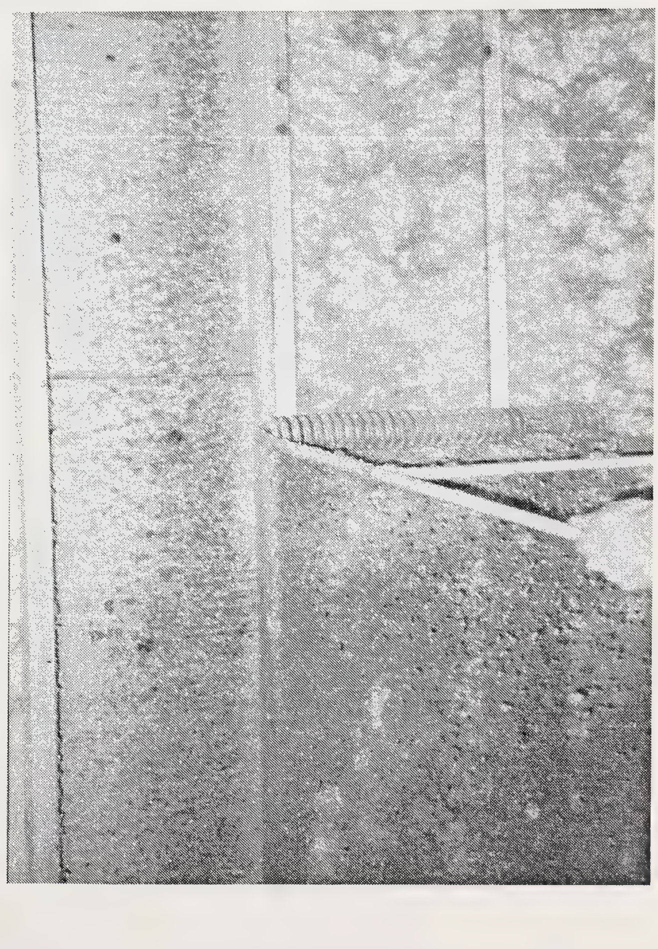


Figure 3.4

Wall Scrubber

4.0 ADHESIVES

4.1 Adhesive Function

The use of an adhesive with this technique does not appear to be a critical factor. Extensive experimentation with water only, with no liquid adhesive or dry adhesive incorporated in the fibre, showed that there is a natural tendency for the moistened cellulose to form a cohesive mat, and to develop a degree of adhesion to the sheathing substrate and studding. However, it is concluded that the addition of about 1% dry adhesive to the cellulose during its manufacture provides better mat integrity, and better adhesion. The use of factory mixed dry adhesive rather than field added liquid adhesive offers the distinct advantage of product consistency, and avoids the logistical problem of providing a liquid adhesive on the job site.

4.2 Adhesive Type

The type of dry adhesive used does not appear to be critical. Low cost, good adhesion to cellulose type fibre, ready soluability in cold water, and permanent set following cure are the essential requirements. Our work involved a powdered acrylic polymer which worked quite satisfactorily.

5.0 MOISTURE DISSIPATION

5.1 Moisture Absorption

Since spray applied cellulose insulation contains about 50% water by weight, there is a need to dissipate the moisture over time. The concern is that the wood framing members become saturated and unable to dry satisfactorily. Enquiries were made to the Wood Products staff at the Alberta Research Council and to Forintek Canada in Ottawa. Their opinion was that the moisture content of cellulose insulation installed in reasonably dry wood framed wall structures (8% moisture by weight) would be absorbed by the structure until a state of moisture equilibrium was reached.

Our calculations indicated a standard 2" x 6" framed wall with 5/16" plywood sheathing and 1/2" drywall panelling would weigh about 5 lbs. per sq. ft., including .4 lbs. of water (at an 8% moisture level). The weight of moistened insulation added to the stud cavities would be approximately 3 lbs. per cubic ft., so the dry assembly materials would then be (4.6 + 1.5) = 6.1 lbs. per sq. ft. and the moisture component would total (.4 + 1.5) = 1.9 lbs. per sq. ft. On reaching a state of moisture

equilibrium, the overall moisture content of the assembly would be about 24%. Of course, if a tight poly vapour barrier were installed under the drywall, then the wood framing and plywood moisture equilibrium would be higher than 24%. Since 19% is accepted as the maximum acceptable figure over the longer term, there is a need to demonstrate that the whole assembly will dry over time.

5.2 Moisture Evaporation

Whereas the redistribution of moisture throughout the assembly, as reflected in 5.2 above, indicates the overall moisture level will tend toward acceptable values, the net moisture loss through evaporation is of more importance in the long run. An extensive series of tests conducted in our plant indicated a relatively rapid drying through evaporation during the first 24 hours after application, provided the surface of the insulation mat was exposed to ambient air. The rate of evaporation depended on many variables such as relative humidity, air movement, starting moisture content and the type of fibre involved. Our trials resulted in initial 24 hour moisture loss rates varying from 6.5% to over 30%. Loss rates after the cavity was enclosed with drywall were much lower, typically in the order of 1/2% per subsequent

24 hour period. Though slow, the ongoing moisture loss from an enclosed cavity occurred on a consistent basis over time. Our tests (Appendix E) indicated that the enclosed wall dried from an initial 42% to an acceptable level of 16% over a 45 day period.

6.0 FIELD USE

6.1 Canadian Experience

Other than the exposed spray type of application referred to in chapter 1.0, which has a long and successful history in Alberta, we did not discover any significant use of wet spray in exterior wall cavities anywhere in Canada other than in the Maritime provinces. It appeared that the use of wet spray for exterior wall insulation has not become generally common for two reasons: (1) because of the additional equipment and specialization involved, wet spray installation is more complex than the traditional glassfibre batt procedure and, (2) there is a commonly held view that introducing moisture into a wall cavity is contrary to good building practise.

Ironically, it seems that the more common use of wet spray in the Maritimes has been advanced as a solution to the general problem of moisture accumulation in the walls of houses insulated with conventional glassfibre. In summary, current evidence indicates that wet spray, in fact, reduces or eliminates longterm moisture problems. The reasons for this are:

1. Cellulose permits very low air flow through the system as compared with glass fibre; thus, smaller amounts of humid air are delivered to the plane of condensation or dew point.

2. Cellulose is an absorptive insulation and tends to store water during cold condensation periods for release later during higher temperature periods in the thermal cycle.

6.2 U.S.A. Experience

Early in our investigations we encountered articles on the use of wet sprayed cellulose (Appendix D) which indicated there were builders in the U.S. who used this system extensively. Following up one such lead, we visited a U.S. builder who was active in the area around Denver, Colorado (Columbine Homes). Columbine reported an annual construction volume of about 250 homes, almost all of which were specifically designed to meet the demands of the energy conscious home buyer. Columbine had gone exclusively to wet spray cellulose for the walls of their new homes because it was found to be the most cost effective way to obtain the low level of air leakage desired. Columbine stated one of their sales promotion

features was a low air leakage rate similar to that in the Canadian R2000 program. The air tightness integrity of their houses was supported by a blower door test figure for each house. Columbine admitted to a cost premium for the wet spray system but felt that they were compensated by an air leakage reduction factor, relative to glassfibre batt, in the order of 50%.

Indications were that their contract price for R-12 (2" x 4") wall installation was about 25% higher than would be paid for R-12 glass fibre batts, but that the additional work required to achieve comparable leakage values with batts would cost more in total. They also reported excellent customer satisfaction with the cellulose system (sprayed walls and loosefill attic) and that there had been no problems whatsoever with residual moisture in the walls. No specific waiting period was observed for board application following the spray cellulose insulation job. Boarders would occasionally follow behind the spray crew within a few hours. Our visit to Denver took place in January 1987, when below freezing temperatures prevailed on the job site. Columbine's insulation contractor used a conventional loosefill application machine equipped with an external mix type of nozzle similar in design to that used successfully in our own experiments.

7.2 Glassfibre Batt Costs

Cost projections were based on insulating a conventional 2" x 6" stud wall to an R-20 standard. Again the vapour barrier is not included.

Material cost was taken as the list price for FIBREGLAS CANADA insulation offered to insulation contractors effective June 1, 1987.

Based on the above parameters we obtained quotes from two insulation contractors which indicated that a direct cost for installation of R-20 batt was about $.40 per square foot.

8.0 STANDARDS AND REGULATIONS

8.1 National Building Code

The National Building Code does not deal with the matter of spray applied insulation but does state in Section 2.5.1.1, that code provisions are not intended to limit appropriate use of materials or methods of design not specifically described therein.

8.2 Alberta Building Code

The Alberta Building Code also omits reference to spray applied insulation. An application to the Director of Building Standards for a product listing authorizing use of WEATHERSHIELD wet spray insulation in the walls of buildings was granted under Product Listing Bulletin #126, May 2, 1987 (See Appendix F).

8.3 Canada Mortgage and Housing Corporation (C.M.H.C.) Evaluation

Communication with C.M.H.C.'s Materials Evaluation Department in Ottawa established that their acceptance of a wet spray wall system will be based, in part, on product conformance to CGSB 51-GP-36P, (see 8.4 below) and on their departmental assessment of actual field installations.

In pursuit of the above objective, our firm is participating in an Ottawa based Task Force comprised of persons from C.M.H.C., The National Research Council (N.R.C.), Forintek and C.I.M.A.C., the latter being the National Association of Cellulose Manufacturers. This task force has the stated objective of conducting field evaluations as required to ascertain the performance parameters of wet sprayed cellulose in house walls.

8.4 Canadian General Standards Board (CGSB)

CGSB has published product standard 51-GP-36P, which is a comprehensive list of performance criteria for spray applied cellulosic fibre.

The main performance items covered by this standard are as follows:

a) Corrosion Resistance - This item checks for corrosive action on wafers of aluminum, copper, steel and galvanized metal. The pass criteria requires acceptable formulations to perform as corrosion inhibitors.

b) Smoulder Resistance - This item requires that smouldering ignition, such as might be started by a

lighted cigarette, or overheated electrical wire, will self extinguish once the ignition source becomes inactive.

c) Flame Spread Classification - This item sets performance parameters for flame spread, smoke development, and fuel contribution.

N.B. This item is more pertinent for exposed spray applications than for enclosed wall cavities. Cellulose materials meeting this performance standard usually qualify for use in "non combustible structures" by achieving a flame spread of less than 25 when tested in accordance with CAN4 S102.

d) Fungi Resistance - This item requires test material to display inhibited fungal development following innoculation with specified spore bodies.

N.B. The borate component used in cellulose insulation also inhibits the decay of wooden framing members.

e) Thermal Resistance - This item determines the resistance value of a spray applied sample per unit of thickness, and sets a minimum acceptable value.

N.B. R-Values for cellulosic materials are generally comparable to or better than glassfibre, and are more stable over the range of densities and seasonal temperatures which may be experienced in field use.

f) Density - This item determines the density of the sample at which the thermal resistance value was obtained. Densities plus or minus 10% of this value are acceptable.

N.B. Variations in field density do not have a significant effect on thermal resistance of cellulosic material as noted in (e) above.

g) Moisture Absorption - This item determines the moisture gain measured under conditions of very high relative humidity, and also specifies the maximum level permissible.

8.5 Conformance to Specifications - Weathershield Insulation

WEATHERSHIELD insulation as used in our research projects was submitted to the National Research Council, Forintek Canada and Underwriters' Laboratories of Canada for testing in accordance with CGSB 51-GP-36P. All of the test criteria were met.

9.0 FIELD TRIALS

9.1 Research House - Duplex

Following an extensive series of experimental applications in mockup wall cavities in our plant, we proceeded with our first actual field application. Arrangements were made with Howell-Mayhew Engineering Inc. to participate in their "Cold Climate Demonstration House" built in Edmonton during the early winter of 1986/87. Our firm insulated the attic and upper walls of one half of the subject duplex with WEATHERSHIELD loosefill insulation and sprayed applied WEATHERSHIELD to the rim joist and 2" x 6" stud cavities of the wood framed basement. The installation was done in December before the regular heating system was operational. Portable propane heat was used to maintain temperature at about 2 degrees C. during application. The walls were boarded three days after spraying. A blower door test on the subject space produced good results of 1.1 air changes per hour at 50 pascals, which was very much better than that obtained on the other half of the structure where no cellulose had been used.

Although no moisture monitoring apparatus was installed in this house, a 6" x 6" opening was cut into the north wall

on June 21, 1987, and a full depth sample of WEATHERSHIELD material was removed for moisture measurement. A moisture analysis done in our lab established the moisture content at 16%. A second analysis done by Howell-Mayhew Engineering March 17, 1988 yielded a moisture content of 13.4%.

9.2 Business Office

During January, 1987 the office walls of Allied Paper Savers Ltd. were sprayed with WEATHERSHIELD. These wall cavities were formed by the 8" deep depressions in the precast concrete panels used as the wall structure. The walls were polyed and panelled immediately following the spray application. In this example the interior temperature was maintained at about 20 C. while outside temperatures varied from about 0 C. to -20 C. The west wall of the subject building was opened June 21, 1987 and a full depth sample of insulation was removed for testing. The moisture content was determined to be 12%.

9.3 Bi-Level Bungalow

Following the above favourable developments we next arranged a full scale field test on a newly constructed

Edmonton house. This building had conventional 2" x 6" framing above grade and 2" x 4" furring inside the 4' high concrete pony wall. The attic was insulated to R-40 with WEATHERSHIELD loosefill and both levels of wall were insulated with spray applied WEATHERSHIELD June 28, 1987.

A moisture calculation on a representative sample of the sprayed wall insulation yielded a moisture content of 50%. A sample removed from the wall 24 hours later, just prior to boarding, yielded a moisture content of 42%.

Three days following the spray application, after boarding was completed, a blower door test was performed which yielded an air leakage rate of 1.41 ACH at 50 pascals.

A 2" opening was cut into the north wall of this house March 1, 1988 from which an insulation sample was extracted. The sample was sealed in a plastic bag and taken immediately to our lab where a weigh-dry-weight procedure revealed a moisture content of 15%.

9.4 <u>Two Story Test House</u>

Following our participation in meetings with the Ottawa

task force referred to in Section 8.3, CMHC tendered a contract whereby Building Envelope Engineering, a Calgary engineering firm, was hired to conduct a 12 month evaluation of a house in which spray applied cellulose was used as wall insulation. The subject house was built in Sherwood Park by Lincolnberg Homes of Edmonton, and Can-Cell Industries spray applied WEATHERSHIELD TA insulation to the upper and main floor walls, and basement rim joists Nov. 10, 1987. Prior to the wall spray application, moisture pins were installed in sheathing, studding and plate lumber by the engineering consultant to monitor wall moisture content. At the time of application the insulation was determined to have a moisture content of 51%, framing lumber an average of 8% and sheathing an average of 7%. Drywall was hung in the monitored wall areas approximately 48 hours following application of the wall spray. The basement walls were furred out about 5", and were sprayed December 17, 1987.

The moisture readings of the sheathing and framing material climbed to 41% and 37% respectively in the two weeks following application, and then declined steadily to 19% and 14% during the following eight weeks.

10.0 Conclusions and Recommendations

This project set out to develop the technology required to spray apply cellulose insulation into the exterior wall cavities of houses, and to determine if such an application could be done so as to meet the general performance criteria of the building industry and relevant government authorities.

Extensive experimentation was conducted with various types of spraying systems in an effort to identify a practical process by which a moderately moist, stable mass of insulation could be installed in an open faced stud cavity. Further testing was done to determine moisture dissipation rates after installation was completed, and to determine air leakage performance of the subject wall systems.

It was established that the moisture introduced during application does dissipate over a relatively short period of time, and that this interim moisture load does not appear to cause any significant detrimental effects. It was further shown that air leakage with this system was reduced to the point where air change rates of less than 1.5 air changes per hour at 50 pascals could be achieved without the extensive air sealing procedures otherwise required with conventional wall insulation.

On the basis of the work done it appears that spray applied cellulose insulation offers a distinct advantage over glassfibre batt in its ability to do double duty as both a thermal barrier and an air barrier. Acceptance of this system has been received from Alberta Building Standards and is anticipated from CMHC on successful completion of the monitoring program underway on the Sherwood Park test house.

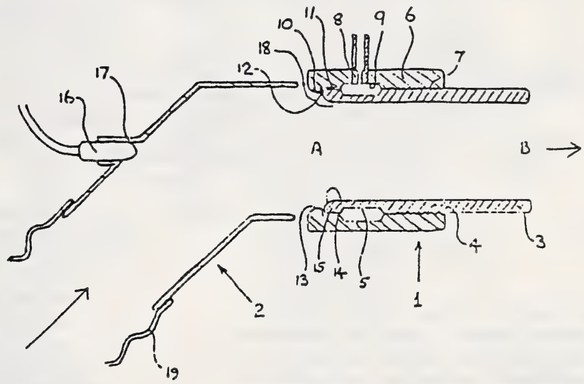
APPENDIX A, B and C - U.K., U.S. and CANADIAN PATENTS FOR SPRAY NOZZLE DESIGNS

(12) UK Patent Application (19) GB (11) 2 149 691 A

(43) Application published 19 Jun 1985

(54) **Coating and spraying solids**

(57) A spray head which will deliver a spray of solids and liquid utilises an air mover into which compressed air is fed creating a low pressure zone A at one end, and nozzle outlet B at the other. In use solids from pipe 19 and a spray of liquid from jet 16 are directed into the low pressure zone whence they are mixed and flung out of the nozzle outlet. The air mover comprises a Coanda nozzle 12-15.



of a jet to travel close to a wall contour, even if the wall's direction of curvature is away from the jet's axis.

Creation of a low pressure zone at A applies suction to the inlet pipe 2.

The inlet pipe 2 is separated from the air mover 1 by a small annular air gap 18, to act as an air bleed in the event of the inlet pipe being closed off. The inlet pipe has a bend, thus enabling a spray jet 16 to be mounted in the wall of the pipe at 17, the jet 16 being positioned on the axis of the air mover 1, without interferring with the fibre flow through the pipe.

A flexible pipe 19 connects the inlet pipe 2 with a supply of fibres and air (not shown) eg a centrifugal fan with a feed means for fibres, arranged to blow air and fibres along the flexible pipe 19.

In operation compressed air is applied to the inlet 8 of the air mover, and fibres, such as celllose fibres, are blown along the pipe 19 and into inlet pipe 2. The suction generated by the air mover pulls the fibres into zone A and accelerates them out of the air mover through the nozzle zone B. The spray jet 16 sprays a liquid, such as UF resin binder solution, onto the fibres in zone A, the effect of the air mover being to intimately mix the liquid spray droplets and the fibres and fling them out through the nozzle zone B.

The spray head thus described is particulary suitable for spraying a fibrous insulation material onto a substrate such as a wall, ceiling or roof interior.

The spray head consists principally of an air mover 1 and an inlet pipe 2 for a current of air and fibres.

The air mover is a known device which utilizes the Coanda effect to generate a low pressure zone at A and force a current of air out through zone B. The device briefly consists of a metal tube 3, whose outer surface is threaded at 4 and contains a groove 5, and a metal sleeve 6, which is internally threaded at 7. The sleeve 6 also contains a compressed air inlet 8 and an internal groove 9 and ends in a flange portion 10.

The sleeve 6 is screwed onto the tube 3 and positioned so that the two grooves 9 and 5 together form an annular chamber to which compressed air can be fed through the inlet 8. The tube portion 15 and inner surface of the sleeve and flange are so dimensioned and positioned that a narrow annular gap 11 for passage of air from the annular chamber remains between the two turning through a right angle and forming an annular slit 12 on the interior of one end of the air mover device 1.

The surfaces 13 and 14 of the flange portion 10 and tube portion 15 are accurately shaped in curved cross section, and the slit 12 is so dimensioned that in operation when compressed air is applied to the inlet 8 the air is forced through the slit 12 and exits from the interior of the air mover through zone B creating a low pressure zone at A. The operation of the air mover utilizes the Coanda effect, which is the tendency of a fluid coming out

Appendix A

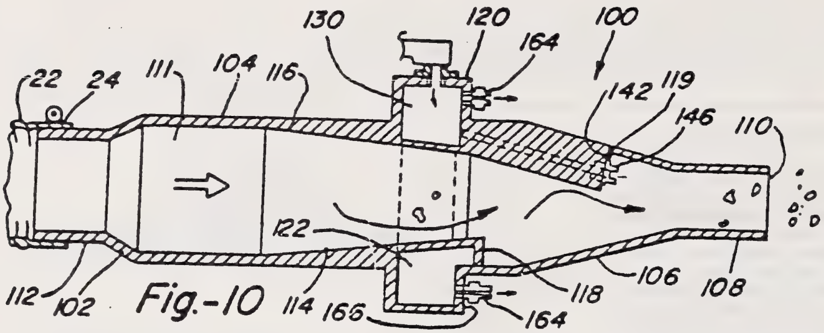


Fig.-10

The present invention utilizes a venturi principle whereby the reduced change in size of the nozzle converts the energy from a high pressure condition to a high velocity condition. The body or main portion of the nozzle is usually of an enlarged size which is similar to or the same as the conventional flexible air hose which is utilized in the insulation blowing machines for transporting and directing the fiberous material to the desired location. The flexible hose is attached to one end of the body portion of the nozzle. The opposite end of the nozzle is formed as a reducer which provides a transition from the larger diameter to the a smaller diameter of approximately one-third the size. The reduced diameter or exit section can be of any length desired but is usually at least 4" minimum to exceed the width of a standard brick. Usually the transition section of the nozzle is of a smooth inner surface and provides a gentle change from the larger diameter body to the smaller diameter exit or outlet section.

In the basic nozzle a high pressure auxiliary air or gas tube is provided on the inside of the transition portion with the downstream outlet of the tube positioned adjacent to the inside surface of the reduced size exit portion. A threaded boss or external connection for an auxiliary source of high pressure air or gas can be provided on the outside of the nozzle either in the body or transition portion to supply air to the internal tube. The tube in its present position acts as an ejector to further produce a lower downstream pressure in the transition portion to aid in pulling the fiber insulation particles through the reducing section and force or push these particles through the outlet opening so they move easily through the nozzle without packing or clogging. Thus, the auxiliary gas stream provides two functions of pulling or aiding the fiberous material through the reducing section of the nozzle and pressurizing and pushing these same particles through the nozzle so that they clear the nozzle without problem.

bore and arranged to lie along the side surface of the transition portion with the outlet opening of the tube positioned in a tangential arrangement along the inside surface of the exit portion. The tube 32 can have a ¼" internal diameter or smaller as desired. The outlet end of the tube 32 is positioned slightly downstream of the end of the transition portion 14 so that fluid exiting from the tube will be directed along the side so as to cause a channeling or tunnel feeding effect on the fibers passing through the exit portion.

It is desirable for the proper function of this invention that the tube closely adhere to the inside surface of the nozzle to obtain the desired results.

As illustrated in FIG. 2, an auxiliary, high pressure source of gas such as air can be connected to the threaded boss 30 by a hose 33, tee fitting 34 having a pressure gauge 36 mounted therein, a manual valve 38 which in turn is connected to a threaded coupling 40 inserted into the threaded boss 30. The valve 38 is merely provided to control the flow of air through the exit portion when the fiberous material is being applied.

It is to be understood that any type of fitting, coupling and valve arrangement desired can be utilized with this nozzle and any type of hose or high pressure source can be utilized. It is also important to remember that any suitable gas can be introduced through the internal ejector nozzle arrangement which is described herein.

In operation, the blowing machine is started and the desired fiberous insulation materials such as fiberglass, Rockwool, cellulose insulation or any other type of fiberous or particle insulation is introduced to the machine. In the conventional insulation blowing machine it is common to utilize a volume of air for transporting the fiberous material of as much as 230 cubic feet per minute at a pressure of 4–6 psi. With the reducing nozzle which is provided by the present invention it is possible to reduce the carrier air flow down to approximately 25 cubic feet per minute with a slightly higher pressure of 15 to 20 psi. Only minor adjustments are required to be made on the conventional blowing machines to make this change.

(11) (CA) **CANADIAN PATENT** No. 951597

(54) SPRAY COATING APPARATUS

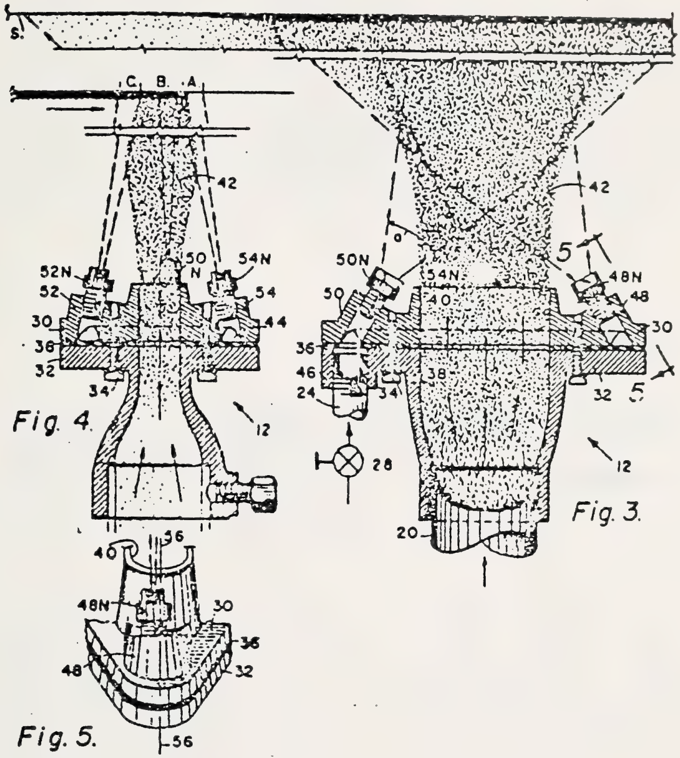


Fig. 4.

Fig. 3.

Fig. 5.

1. A spray gun comprising a body, said body having a generally oval shaped dry material outlet orifice centrally thereof, said oval shape having a relatively long major axis and a relatively short minor axis normal to said major axis, means for supplying dry material for ejection through said orifice, first and second spray tips mounted on said body adjacent and offset from said major axis of said orifice and at diametrically opposite sides thereof, means for applying a fluid adhesive to said spray tips, said spray tips each being adapted to form a flat fan-shaped stream of adhesive, said spray tips being oriented relative to one another such that the plane of the fan-shaped stream of said first spray tip is parallel and spaced from the plane of the fan-shaped stream of said second spray tip, said spray tips being oriented so that the streams produced thereby are parallel to said major axis and slice through the path of egressing dry material from said orifice to form a long narrow mixture of dry material coated with adhesive in front of said gun.

APPENDIX D - ENERGY DESIGN UPDATE FEATURE

ON CELLULOSE INSULATION and AIRTIGHTNESS

(Reprinted with Permission)

Energy Design update

The Monthly Newsletter on Energy-Efficient Housing, from Cutter Information Corp.

J.D. Ned Nisson, Editor

Reprint December 1986

CELLULOSE INSULATION AND AIRTIGHTNESS

The following letter is one of several we have received asking or commenting about the effect of cellulose fiber insulation on building airtightness:

To the Editor:

I have heard two claims for cellulose insulation that I would like to confirm if possible. The first is that because of its density and compactness, cellulose insulation significantly reduces air leakage through the exterior skin of a house. In other words, houses insulated with cellulose insulation are tighter than houses built with fiberglass batts. The second claim is that unlike fiberglass batts, blown cellulose does not allow convective air loops to form within the insulation layer. If these claims are true, then cellulose seems to have some distinct advantages over fiberglass batts.

Any information you have supporting or refuting these claims will be appreciated.

Cynthia Wells, Chicago.

Research has shown increased building tightness with cellulose insulation.

A 1979 study performed by Seton, Johnson and Odell for the Oregon Department of Energy found the measured air leakage of homes insulated with cellulose fiber insulation (CFI) to be 15 to 20% less than the air leakage of homes insulated with other insulation materials. Blower door tests of 71 homes found the average leakage for cellulose homes to be 10.6 air changes per hour at 50 Pa, compared to 13.0 ach for homes insulated with rock wool (Figure 1). Only limited conclusions can be drawn from these data since the houses differed in other ways in addition to insulation type, but the trend for greater tightness with cellulose is probably valid.

A more formal investigation on this topic was conducted in 1984 by David Jacobson, David Harrje, and Gautam Dutt at Princeton University. They built a simulated attic floor consisting of a test platform with intentional cracks in it. Using a controlled pressure device, air was forced through the cracks in the platform, first with no insulation on it, then successively with cellulose, fiberglass batts, fiberglass blowing wool, and finally vermiculite on it. The relative reduction in airflow caused by the various insulation materials was measured. The results are shown in Figure 2. The greatest reduction was caused by the cellulose insulation.

The Princeton researchers also performed three field tests to measure the reduction in air leakage in houses retro-insulated with blown cellulose. Three houses were pressure tested with a blower door before and after retro-insulating the walls with cellulose. The results are shown in Figure 3. In two houses, the reduction was enormous, but in a third, the reduction was only 3.6%. [The two houses with high reductions in air leakage both had balloon framing which was probably open to the attic.]

Finally, a telling illustration of cellulose's ability to block air leakage is described in a just-released report from the Minnesota Department of Energy and Economic Development:

During inspection of a group of energy-efficient houses built under the Minnesota Energy Efficient

For more information, contact:

CUTTER INFORMATION CORP.
1100 Massachusetts Avenue
Arlington, MA 02174, U.S.A.
Telephone: (617)648-8700

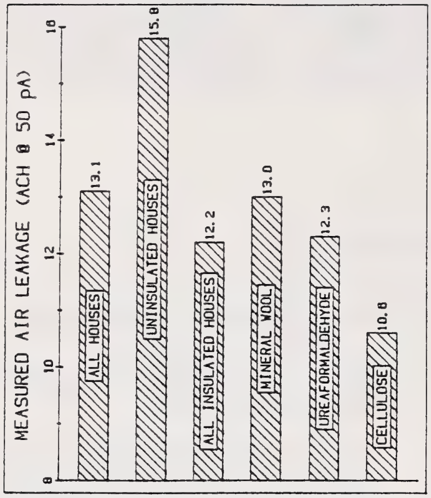


Figure 1 - Measured air leakage of homes insulated with various types of insulation. *Source: Princeton University*

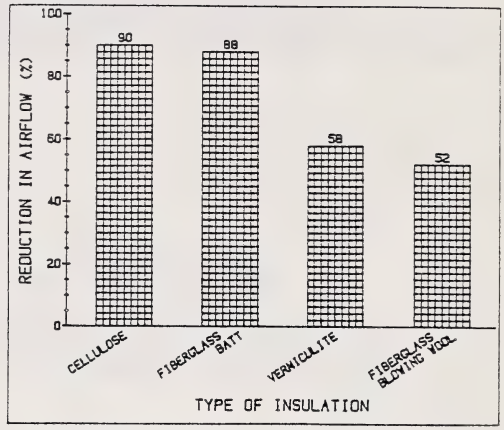


Figure 2 - Percent air leakage reduction in test chamber with various types of insulation.

Source: Princeton University

Housing Demonstration (EEHD) program, one defect noticed in many houses was air leakage into the attic through wiring holes and other penetrations in the top plates of interior partitions. In one house, the Minnesota research team was surprised to see almost no partition wall leaks into the attic during scanning examinations with an infrared camera. The initial conclusion was that the builder had been careful to plug those leaks during construction. However, when the cellulose insulation in the attic was removed, holes and cracks were in fact found around the interior partitions. The cellulose was actually sealing leakage points inadvertently left open by the builder.

But cellulose insulation is not an air seal.

The impressive results cited above should not be interpreted to mean that cellulose insulation can provide an effective air barrier in a building envelope. Even though it may retard air leakage, cellulose insulation still allows air to pass through and will not completely prevent heat loss or moisture damage due to air leakage. A graphic illustration of this fact is shown by the photos in Figures 4 through 7, taken by Gary Nelson as part of the Minnesota EEHD monitoring project.

Figure 4 shows a section of attic insulated with cellulose. The installation looks pretty good, but if you look closely you will see that the cellulose has settled in the area over the soffit at the top of the photograph. The cause of the settling was wetness. Also, water stains can be seen on the wood framing.

Figure 5 shows the same area with some of the cellulose removed. The pencil in the photograph is sticking in a gap between a 2 x 4 and a piece of plywood. The pocket knife is shown sticking into a gap between the plywood and the top plate of the exterior wall. There was apparently no attempt to seal these gaps and moisture laden air was evidently leaking up into the attic from the space below.

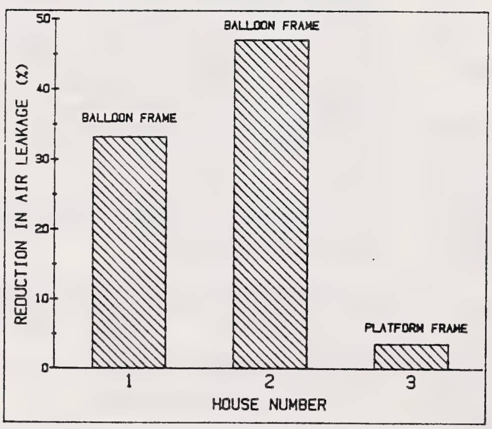


Figure 3 - Percent reduction in air leakage after cellulose wall insulation retrofit. *Source: Princeton University*

Figure 4 - Attic insulated with cellulose. Settling over soffit was caused by insulation being wetted by moist air leakage through attic floor.

Figure 5 - Attic floor showing points of air leakage.

Figure 6 - Kitchen soffit below attic area shown in figures 4 and 5.

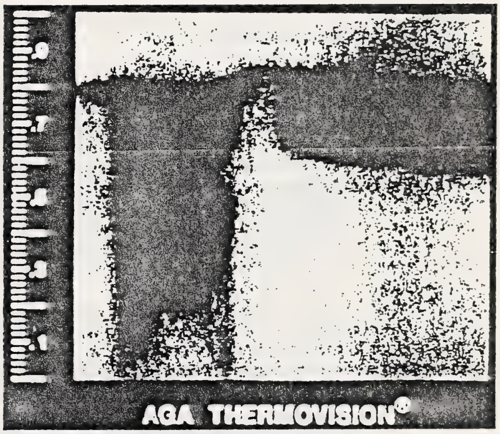


Figure 7 - Thermogram of kitchen soffit area taken with house depressurized. Dark areas indicate cold air leakage from attic.

Figure 6 is a photo of a kitchen soffit located directly below the attic area shown in Figures 4 and 5. Figure 7 is a thermogram of the same area taken with the house depressurized. The dark spots indicate cold. The soffit is cold due to attic air leaking down from above.

Blower door tests of this house showed it to be reasonably tight (about 3.4 air changes per hour at 50 Pa) and the cellulose insulation was probably responsible for a certain degree of that tightness. However, the defects illustrated in Figures 4 through 7 suggest that even though the insulation may suppress air leakage, it is not effective enough to serve as a good air barrier.

Wet-spray cellulose Is a different story

The most impressive air sealing effect of cellulose is seen when it is applied as a wet spray (see September 1985 EDU for complete discussion of wet-spray insulation). We have received two reports from EDU readers about side-by-side comparisons of the air

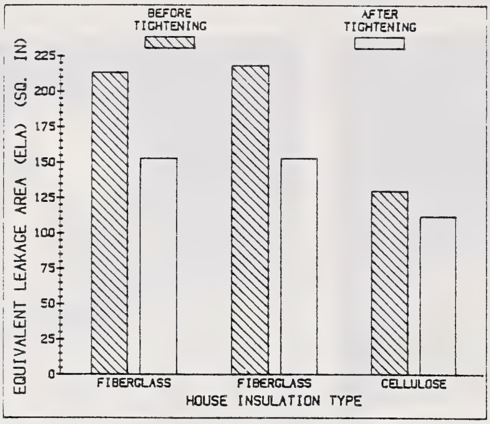


Figure 8 - Comparison of measured air leakage of buildings insulated with fiberglass and buildings insulated with cellulose.

Source: Richard Piper, Mass. Exec. Office of Communities and Development

leakage characteristics of new houses built with wet-spray cellulose versus fiberglass batt insulation.

The first case is the Leominster Housing Project for the Elderly in Leominster, Massachusetts. Two of the buildings in the project have R-13 fiberglass batts in the walls and R-38 fiberglass batts in the ceilings. A third building is insulated with wet-spray cellulose in the walls and blown cellulose in the attic.

The three buildings were pressure tested with a blower door at the completion of construction. Some air sealing work was then done and the buildings were retested. Figure 8 shows the results of the tests. The effective leakage area (ELA) of the building with cellulose was 40% lower than the average ELA of the two buildings with fiberglass before the air sealing work and 27% below the fiberglass buildings after the air sealing work.

The other case study was told to us by Bill Richardson, president of Columbine Homes, in Aurora, Colorado. Richardson is a volume builder who markets his homes largely on their energy efficiency. Last year Columbine built 250 homes. Each one built was tested for air leakage with a blower door.

Richardson compared the air leakage rates of homes insulated with fiberglass batts against the air leakage rates of homes insulated with wet-spray cellulose. He found that, all else being equal, the air leakage of the houses insulated with cellulose was generally about half that of the houses insulated with batts. The Columbine formula for achieving airtightness now includes cellulose insulation as an integral component along with a system of gaskets and caulking similar to that used in the "airtight drywall approach" (ADA).

Air circulation within insulation is unproven.

The second part of Cynthia Wells' inquiry letter, referring to the suppression of internal air movement within cellulose, is probably also true; to our knowledge, no one has demonstrated the presence of air circulation within cellulose. However, we have also not seen any discrete evidence showing the presence of air circulation within fiberglass batts either. We have seen, and have occasionally published, evidence of air circulation around and over fiberglass batts, but not within the batts. Air circulation around fiberglass batts is usually the result of gaps and spaces produced by imperfect installation. An advantage to cellulose in this respect is that gaps and spaces are less likely to occur.

SUMMARY AND CONCLUSION

Cellulose fiber insulation suppresses air leakage to a much greater extent than other types of insulation. In fact, when analyzing the cost-effectiveness of cellulose retro-insulation, one should probably factor in energy savings due to infiltration reduction. In new construction, cellulose has the advantage, common to most loose-fill insulation materials, of complete filling of cavities, avoiding gaps and spaces which can lead to convective degradation of thermal performance. It cannot, however, be relied upon to correct flaws in the house air barrier.

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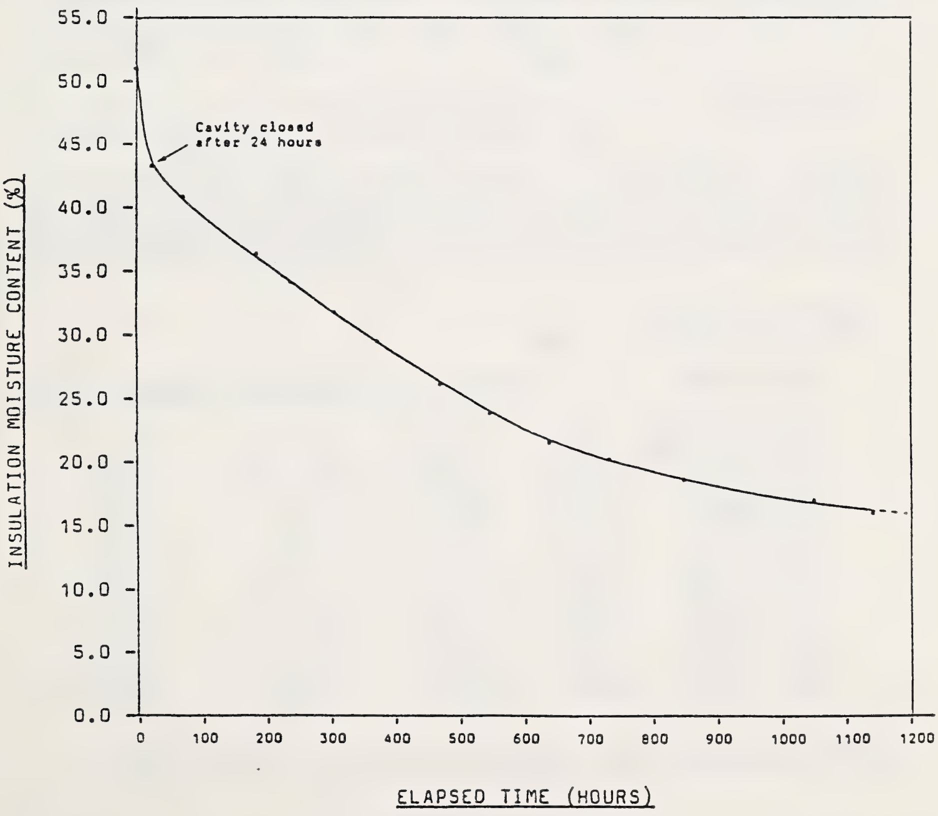
APPENDIX E - DRYING CHARACTERISTICS OF A WALL SAMPLE CONTAINING SPRAY APPLIED CELLULOSE INSULATION

RE: Drying Rate of Cellulosic Fiber in a Closed Wall Cavity

- wall unit (4'x4') constructed of standard 2x6 spruce with 3/8" plywood backing
- spray-filled with TCI-75 Architectural Tan (water only)
- unit closed with poly/gypsum board after 24 hours
- moisture contents calculated from weight determinations

(see front of page for detailed results)

DRYING CHARACTERISTICS - CLOSED CAVITY



15/04/87

DETERMINATION OF DRYING CHARACTERISTICS:

I. DRYING RATE OF CELLULOSIC FIBER IN A CLOSED WALL CAVITY

Description:

A 4' by 4' wall unit was constructed of standard 2x6 spruce placed approx. 16" O.C., giving three "stud spaces" (45" in length, 5½" in depth, and widths of 13½", 14½", and 13½") totalling 5.98 cubic feet (169.3 L) in insulatable volume. With a 3/8" plywood backing, this unit weighed 53.8 lbs. (24.4 kg).

The wall unit was spray-filled with TCI-75 Architectural Tan using only water and was re-weighed (water flow rate at 2.4 L/min.- spray time was approx. 3 minutes).

After 24 hours, weight was again determined, and the wall unit was closed using 4 mil polyethylene, standard ½" gypsum board, and dry-wall screws (total added weight was 23.8 lbs. (10.8 kg)).

Weights were recorded at measured intervals and, after 1140 hours, the unit was dismantled. Samples from each "stud space" were taken (sample volume measured) to determine remaining moisture. The average of 15.9% gave a calculated 19.4 lb. (8.8 kg) dry material load and an average oven-dried density of 3.24 lb./cu.ft. (51.98 kg/cu.m.).

Detailed Results:
- see graph on back of page

DATE & TIME	TIME ELAPSED	NET WEIGHT	MOISTURE CONTENT
February 24/87- 15:00	0 hrs.	13.3 kg	51.1 %
February 25/87- 15:00	24 hrs.	12.5 kg	42.0 %
February 27/87- 16:00	73 hrs.	12.4 kg	40.9 %
March 04/87 - 08:00	185 hrs.	12.0 kg	36.4 %
March 06/87 - 15:00	240 hrs.	11.8 kg	34.1 %
March 09/87 - 13:00	310 hrs.	11.6 kg	31.8 %
March 12/87 - 07:00	376 hrs.	11.4 kg	29.5 %
March 16/87 - 07:00	472 hrs.	11.1 kg	26.2 %
March 19/87 - 13:00	550 hrs.	10.9 kg	23.9 %
March 23/87 - 09:00	642 hrs.	10.7 kg	21.6 %
March 27/87 - 14:00	737 hrs.	10.6 kg	20.5 %
April 01/87 - 07:00	850 hrs.	10.4 kg	18.2 %
April 09/87 - 15:00	1050 hrs.	10.3 kg	17.0 %
April 13/87 - 09:00	1140 hrs.	10.2 kg	15.9 %

Prepared by C.L. Travis, Department of Quality Control & Research, CAN-CELL INDUSTRIES INC., 16355-130 Ave.N.W., Edmonton, Alberta.

APPENDIX F - ALBERTA LABOUR, BUILDING STANDARDS BRANCH PRODUCT LISTING STANDATA FOR SPRAY APPLIED INSULATION

PRODUCT LISTING

STANDATA

NO. 85 PL 126

CATEGORY: INSULATION (Spray Applied)

ISSUE DATE: 1987 07 15 REVIEW DATE: 1989 07 15

MANUFACTURER: CAN-CEL Industries Inc.
16355 - 130 Avenue N.W.
Edmonton, Alberta T5V 1K5

REPRESENTATIVE IN ALBERTA: CAN-CEL Industries Inc.
16355 - 130 Avenue N.W.
Edmonton, Alberta T5V 1K5

PRODUCT:

WEATHERSHIELD SPRAY APPLIED INSULATION

DESCRIPTION

Weathershield Spray Applied Insulation is a loose-fill cellulose fibre thermal insulation with powdered adhesive added. This dry mixture of insulation and adhesive is mixed with a controlled percentage of moisture and is propelled by a special machine. This produces a cohesive mat which adheres to the studs and sheathing.

USE AND LIMITATIONS

Weathershield Spray Applied Insulation may be used as a thermal insulation in walls and ceilings provided:

- the wall or ceiling is allowed to be of combustible construction,
- the insulation is not directly in contact with soil or moisture, and
- the application of the insulation is carried out in strict conformance with the manufacturer's instructions and the applicators are authorized by CAN-CELL Industries Inc.

Where Weathershield Spray Applied Insulation is used in ceilings, the roof space or attic above the insulation shall be ventilated in accordance with Article 9.19.1.1.

Where the roof does not incorporate an attic, cross purlins of at least 38 mm by 38 mm shall be applied to the top of the roof joists and the top of the insulation shall be at least 25 mm below the top of the roof joists. (Article 9.19.1.3.)

ISSUE OF THIS LISTING IS AUTHORIZED UNDER SENTENCE 1.5.4.2(9) OF THE ALBERTA BUILDING CODE 1985 BY THE DIRECTOR OF BUILDING STANDARDS D. O. MONSEN, M.R.A.I.C.

Alberta

OR

Where the roof slope is 1 in 6 or greater and the roof framing members run in the same direction of the slope, a minimum clearance of 75 mm shall be maintained between the top of the insulation and the underside of the roof sheathing throughout the length of the roof joists. Vents in such roofs shall be provided in such a way that 50 per cent of vent area is at the ridge and 50 per cent at the lower part of the roof. (Article 9.19.1.4.)

CODE REQUIREMENTS

Sentence 9.26.2.3.(1) of the Alberta Building Code 1985 states that in all exterior assemblies (walls, floors, roofs, etc.) of a building of residential occupancy and a heated garage serving a building of residential occupancy, thermal insulation conforming to the following table must be provided.

LOCATION OF ASSEMBLY IN WHICH INSULATION IS PLACED		MIN. THERMAL RESISTANCE $m^2 \cdot °C/W$
Wall Assembly (Except Basements)	Building exterior	2.1
	Between building and attached garage	2.1
	Exterior of heated garage	2.1
Basement and Crawl Space	Perimeter walls - top 600 mm below grade	1.4
Floor Assembly	Perimeter	2.1
	Exposed cantilevers	4.7
Roof - Ceiling Assembly	Building - general	6.0
	Heated garage	6.0

In accordance with Article 9.26.4.5. if Weathershield Spray Applied Insulation is used on the interior of foundation walls enclosing a crawl space, a clearance of at least 50 mm must be left between the crawl space floor and the insulation.

TECHNICAL DATA

Weathershield Spray Applied Insulation has been manufactured in compliance with the requirements of CGSB Standard 51-GP-36P, "Standard for Spray

Applied Cellulosic Fibre" (Proposed Canadian Specification 5th draft 22nd April 1981).

INSTALLATION

Unless Weathershield Spray Applied Insulation is used in an existing wall cavity, the sprayed insulation must be left exposed on one side for a minimum period of 24 hours to dry, after which vapour barrier and gypsum board or some other interior finish may be applied.

Weathershield Spray Applied Insulation must be applied in strict conformance with the manufacturer's instructions and by applicators authorized by CAN-CELL Industries Inc.

IDENTIFICATION AND CERTIFICATION

The product is identified by the manufacturer's label on the package.

APPENDIX G - APPLICATION MANUAL FOR SPRAY APPLIED WEATHERSHIELD TYPE TA INSULATION, CAN-CELL INDUSTRIES INC.

WEATHERSHIELD

TYPE TA INSULATION

APPLICATION MANUAL

Spray for Exterior and Sound Wall Cavities

ADVANTAGES AND BENEFITS:

- HIGH STABLE R-VALUE
- CONTROLS AIR LEAKAGE AND CONVECTION
- REDUCES CONDUCTION
- PREVENTS FORMATION OF CONDENSATION MOISTURE
- COOLER SUMMERS
- SEAMLESS BLANKET COVER
- HIGH DENSITY TO RESIST AIR MOVEMENT
- LASTS THE LIFETIME OF THE BUILDING

Mfg. By:

CAN-CELL INDUSTRIES INC.
16355 - 130 Avenue
Edmonton, Alberta
T5V 1K5
(403) 447-1255

Serving Canada Coast to Coast

June 24, 1987

CAN-CELL INDUSTRIES INC.
WEATHERSHIELD TYPE TA INSULATION APPLICATION MANUAL

CONTENTS

Appendix G

June 24, 1987

WEATHERSHIELD TYPE TA is available from Can-Cell Industries Inc.:

- 16355 - 130 Avenue, Edmonton, Alberta, T5V 1K5 (403) 447-1255
- 220 - 19 Street SE, Calgary, Alberta, T2E 6P5 (403) 248-1445
- 14 Archibald St., Winnipeg, Manitoba, R2J 0V8 (204) 233-8526
- Box 8335, Saskatoon, Saskatchewan, S7K 6C6 (306) 477-0044

Fico Ltd.

- Box 245 Mount Royal Station, Montreal, PQ, H3P 3C5 (514) 737-6482

CAN-CELL INDUSTRIES INC.

INTRODUCTION

Weathershield Type TA wall cavity spray is a process that is becoming popular in the insulation industry. It is the unique process of taking loose fill material with a dry binder added during the manufacturing and literally spraying it into the wall cavity. A water mist is added at the nozzle to activate the binder and cause the fibres to assume a cohesive "set".

Weathershield TA provides the optimum density and consistency specifically desired for the spray-on process. This system has been approved by the Federal Housing Agency (FHA) in the United States (similar to CMHC) since October 1979 and has seen widespread use in the new house building industry since then.

Air leakage or air movement through or around an insulation material such as glass fibre batt can reduce the effective R-Value by up to 50%. Air carries moisture vapour outward through cracks and holes in the building structure. When this warm air reaches cool surfaces condensation causes moisture to form. Weathershield's short fibres, high density and seamless blanket cover provides high resistance to air leakage. Weathershield thus prevents formation of condensation moisture and maintains a constant R-value. The result has been a marketable system with performance far superior to that obtained by other segments of the insulation industry.

Insulation blower machines have been improved to deliver the proper flow and consistency needed for application. The improvement of nozzles and the invention of the wall INSULATION SCRUBBER has all come together to make this system a very functional process that can be used in todays market.

Proper installation is not difficult to achieve as there are only three basic criteria which must be met:

1) Fill cavity completely.
2) Install at a moisture content (wet basis) of 50% plus or minus 10%.
3) Install at a density of 3 PCF plus or minus 10%.

Compliance to (1) above may be ascertained visually, assurance regarding (2) and (3) is equally simple in that the material falls out or sags down from the top plate if density and moisture respectively are not correct.

The following procedures are only recommendations by the manufacturer. Good product performance is obtained when the installation is done correctly.

In the event the enclosed recommendations appear to be inadequate, the applicator is invited to consult further with the manufacturer.

CAN-CELL INDUSTRIES INC.

FACTORS EFFECTING HEAT LOSS

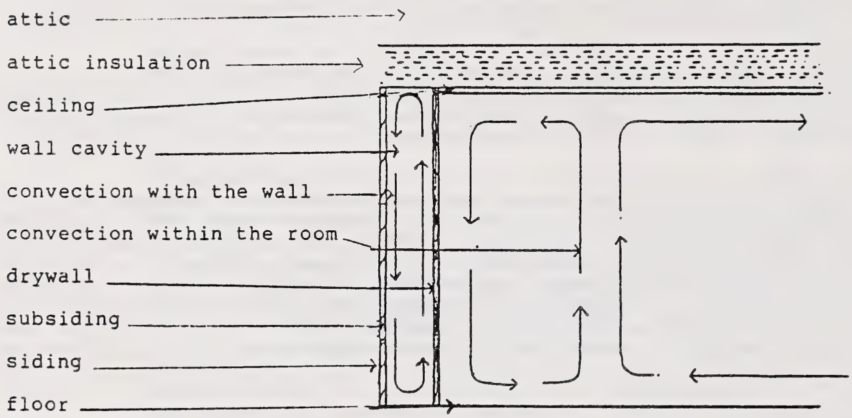
The insulation industry has spent years trying to educate the public to think R-Value instead of inches. Do you know that the public is finally recognizing that R-Value has something to do with the amount of insulation in their house. Unfortunately, when we as an industry finally achieved a small amount of progress in this area of education, we discovered that R-Value does not tell the whole story. It doesn't even tell a very large portion of the story. The truth of the matter is that the insulation industry does not have in their terminology a word that accurately describes performance. The R-Value of one insulation will not necessarily perform the same as the R-Value of another.

Can-Cell Industries Inc. has manufactured spray-on insulations for many years and has discovered that sprayed metal, wood and concrete buildings resulted in excellent performance. Our spray-on products have been used in schools, restaurants, hotels, swimming pools, arenas, warehouses, farm buildings and many other commercial buildings. A good example is the exterior walls of the Northlands Coliseum in Edmonton. No vapour barriers were used in these buildings. The real test concerns four areas of performance. If an insulation performs well in each of these areas, it will perform well in a structure, resulting in low heating costs.

Infiltration. This is the movement of air through walls, around windows and doors, heat vents, plate lines, corners and any other area where air can move through. For good performance, it is essential to control air flow. For many years vapour barriers were used in an attempt to control air flow. Even today this method is still used because of the very basic misconception that a vapour barrier is adequate to stop infiltration. It is now known that vapour barriers do not stop infiltration, nor do exterior type barriers such as rigid foam sheathing. Air leakage is best controlled by the insulation itself. If the insulation component leaks air, infiltration and convection will result. Even if an infiltration barrier results in a tight house it will not necessarily be a warm house. Let us illustrate that by the example of a new house with no insulation. Having determined that infiltration was a major heat loser, lets wrap the entire house with a poly barrier. Would this house then be warm and comfortable? The answer to this question is no, as will be revealed below under "convection". Lets consider the same house with the vapour barrier and a loosely bound insulation fibre of full thickness within the cavity. Would this house be warm and comfortable? Answer: It would be better than with empty cavities, but even though the infiltration is cut out, convection still exists. If we wanted this house to be very comfortable, we would use an insulation product that does not allow free air flow. This would stop the infiltration and convection problem and create a very comfortable house. Urethane and other foam type subsidings which are vapour barriers themselves, should never be put on the outside of exterior walls. Exterior wall membranes should be able to breathe so that any moisture which accumulates may dissipate by diffusion to atmosphere. Although vapour barriers are a separate subject, we are mentioning this so that you will understand that the very best method for restricting air flow is to fill the wall with a material

that resists infiltration, and not rely completely on poly or sidings for control.

<u>Convection.</u> Convection is the circulation of air within a space. Air when heated rises, and when cooled, falls. In a wall, the natural forces of gravity along with warmer inner surfaces and colder outer surfaces create a continuous movement of air.



Starting with the exterior wall cavity, <u>note</u> this process: (This is the normal flow of air within wall cavities and within rooms).

1. The convecting process within the wall.
2. The air cools, moving down the outside of the cavity. (Air drops when cooled).
3. The air heats as it comes up the inside of the cavity. (Air rises when heated).
4. The greater the temperature difference between outside and inside, the faster the convecting process.
5. The faster the convecting process within the wall cavity, the colder the drywall.
6. The colder the drywall, the faster the convecting process within each room of the house.
7. The faster the convecting process within the rooms of the house, the faster the house temperature drops.
8. The faster the house temperature drops, the more fuel will be used to replenish the heat.
9. The more fuel used, the higher the heating bills.

Let us go back to the illustration of the house. We will use a sprayed wall with Weathershield Type TA that controls air flow. This results in very slow or no moving air within the wall cavity. Because this convection within the wall cavity is controlled, the drywall on the inner side of the wall is not cooled quickly. The result being, because of the much warmer drywall, there is a much slower convecting

within the house itself. Slow convecting gives comfort within the room while fast convecting makes a room feel drafty. People will feel more comfortable at a lower thermostat setting with slow convection within the room 65° - 68°F. (18°- 20°C.). When fast convection exists within a room, the thermostat setting for reasonable comfort will be above 70° F. (21°C.). The speed of the convection within the room is determined by the temperature of the drywall on the exterior walls and ceiling. Cold glass from the windows will also speed up the convecting process within the house. Remember, an insulation with the capability to control air flow within the insulation itself, will have a high performance value.

Conduction. Conduction is the transmission of energy moving through a substance. Remember the cool drywall which would speed up the convecting process within the room? Because of the high conductivity of glass, the windows will also speed up this convecting process. Studs which conduct cold will speed up convection. The insulation materials, if they possess conduction qualities, will allow the cold to conduct through and result in a cool drywall surface, thus speeding up the convecting process within the room. "Now just a minute, we thought energy moved through the surface. Since there is more energy stored up in warm air than there is in cold air, then, heat moves out through the walls and ceilings and not the reverse". Yes, this is absolutely true but both processes take place. Just put your hand on the window in cold weather. If cold didn't also move inward, glass would be warm to the touch. We could insulate with reflective surface insulations only and hold the heat in without concern about cold moving in as well. Insulation is necessary; it must be able to control air flow, and it must have non-conductive qualities to obtain high levels of performance.

R-Value. This is the resistance of heat or the measure of heat lost through a material. This test is done in a laboratory, normally using a sample 1 inch thick, with the tested temperature at 75°degrees F. (24° degrees Celsius). R-Value then is testing heat flow through insulation or other materials. Air flow is not part of the test.

Performance Value. Performance of insulation cannot be evaluated before each of the above factors are evaluated individually. To determine the performance of an insulation, one must evaluate its ability to control infiltration, convection and conduction. To sell high performing products, the customer will need to understand the difference between high performing products and R-Value alone. Contractors and builders especially need to understand these factors. If they are genuinely interested in quality of insulation, they respond to this approach. If they accept the idea of Performance-Value, they will be interested in giving you future jobs. The basic reason for this performance is as follows: a) glass fibre batts installed in an exterior wall are dry, but because of air leakage the glass fibre batt is continuously subject to moisture gains through condensation, b) Weathershield Type TA is installed with moisture, but over a short period of time it becomes dry and remains dry on a continuous basis because of its resistance to air leakage and air convection.

EFFECTIVE: June 24, 1987

CAN-CELL INDUSTRIES INC.

WALL CAVITY FILL SPRAY-ON

1. Preparation

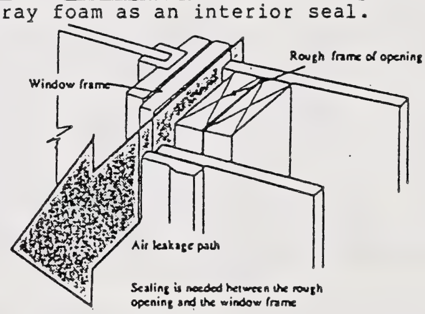
When insulating a building using the Weathershield Type TA spray method, one should plan a two step operation.

Step #1. Preparation (preparing the building for spraying).

Step #2. Spraying of walls.

A. Insulate voids around windows and doors. All voids around windows and door jams should be insulated to cut infiltration from these areas. Various materials are available for this purpose. Materials commonly used are foam backer rod or fiberglass (cut in strips) with 1" to 1 1/2" of urethane spray foam as an interior seal.

B. Cover finish areas. A finish area is an area which must not be damaged, or stained because it will be a finished surface. When spraying, surfaces such as finish wood, glass, steel doors, fireplace faces, and electrical boxes must be covered to keep them clean.



C. Cover electrical boxes. When covering electrical boxes, use two inch tape, preferably polyvinyl. Polyvinyl remains soft and sticky even in cold weather. Cover the box with one piece extending no more than 1/4 inch over the end of the box lengthwise. After the job is completed, you may leave the tape on to protect the box from drywall mud. It would be advisable to discuss the subject of leaving the tape on the box, so that the client understands your reasoning. If he disapproves of leaving the tape on, just pull it off during the clean-up. Alternatively, the box could be stuffed with a piece of glass fibre batt.

D. Cover windows and doors. All windows and doors should be covered with 2 mil or 4 mil poly and stapled every 8 inches to the studs and headers around the windows. Never staple on the jam face, because there is finish wood and will be damaged by the staples. In covering windows, follow these steps:

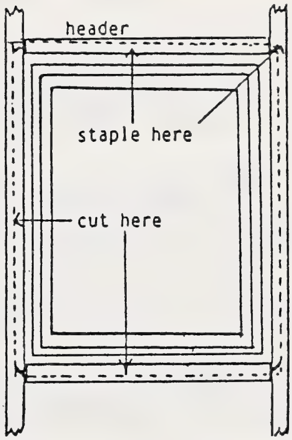
1. Place the poly on the floor. With a utility knife, cut to estimated length. Cut efficiently so as to allow as little waste as possible.

2. Next, place the poly over the window, aligning to the header on one side.

3. Staple poly on all four corners (use two or three staples at each corner).

4. Staple all around window every 8" to studs and header only. Do NOT staple into jam.

5. Cut off excess poly.



Cover all windows and doors before starting to spray to keep moisture and dust from settling on <u>finish wood.</u> Also, cover any other <u>finish</u> products such as installed fireplaces, etc. Tools, boxes of nails, etc., are often found in the buildings and should be covered for protection also. Alternatively, sheets of cardboard could be used to cover windows, doors and finished surfaces.

E. <u>Attic Preparation.</u> If preparing attic hatches, soffits with insulation stops, recessed lights, chimneys or other heat sources, refer to the Weathershield loosefill application manual.

F. <u>Sweep floor.</u> A clean floor is important before starting to spray. If you are recycling through your machine, a <u>totally</u> clean floor is absolutely necessary before starting to spray because objects such as nails, wood, etc. will damage your machine. If you are disposing of the Weathershield Type TA cleaned off the floor, this step may be delayed until the job is finished. It is often possible to manually place fall-out material in the bottom of a wall cavity yet to be sprayed.

II. <u>Setting up equipment for spraying</u>

When setting up equipment, a question is often asked, "with this portable equipment, should I leave it on the truck or carry it into the building?" Let us suggest three factors to consider when making this decision:

Factor #1: Time. Always structure your system around production. Although quality is not affected in either case, the time it takes to set up your equipment should be considered.

Factor #2: Cost. How will you use your employees to your best advantage? Labor costs should be balanced with production. If you are spraying at a pace of 30 bags per hour, you will need someone feeding the machine constantly. In that case, why not leave the blower and bags out in or near your vehicle.

Factor #3: Weather conditions. In cold climates and under extremely cold conditions, you may want to temporarily alter your methods to fit the weather conditions.

A. Heating the building. Heating the building while spraying is only necessary if the temperatures are below freezing. There are only two reasons for heating a building.

First, in below freezing temperatures, your entire spray system can freeze up. The most vulnerable is your pressure hose and your nozzle. When the building is heated, these may be inside. The pump and the inlet pump hose can also freeze. For information on these problems, check under EQUIPMENT in the section called: How to eliminate freeze-ups.

The second reason is comfort. When spraying, the humidity level is high, and you will feel the cold more severely. It is not necessary to heat the building after you have completed the spraying. Much more important is to open all the windows and let the air move the humidity out. You may question our suggestion to not heat after completion, but this is supported by both our experience and that of several U.S. contractors who have had extensive experience in areas where the temperature sometimes drops to -20°F. (-29°degrees C.) or lower in the winter with no problems resulting. We are referring here to spray cavity fill application and not an exposed application with liquid adhesive.

1. Material with regard to freezing. The question often asked is, "Isn't it going to freeze?" The answer to that is yes. Drying time is much slower in the winter, but even when it is frozen, the moisture is being evaporated out of the insulation.

2. The heating system. When heating a building while spraying, the best and most effective heating system to use is a fuel oil or L P gas unit with a fan to move the heat around. When you are spraying walls, the building is uninsulated and the heat goes

straight up. Use 150,000 BTU heaters in sub zero climates. When using these heaters, you should keep them as far away from the area being sprayed as possible because they suck in dust. This will cake on the fans and plug the filters, causing the unit to fail to function properly. Keep them clean, and they will generally be trouble free.

B. Equipment to eliminate freeze-ups. For those cold climates where freeze ups readily occur, additional equipment may be necessary. Often in these areas, water is not available on the jobs. The reason being, that until the buildings can hold heat, they are not heated. With no water available on the jobs, one must haul water to the job sites. When freeze-ups occur, much time is lost. Here are some suggestions to eliminating freeze-ups: (These suggestions are for trucks or large trailers).

1. Obtain a large plastic tank of approximately 300 gal. (farm field spray tanks work well). This should be strong enough to handle the movement of water as you are driving.

2. Build a large insulated box across the front of the truck box. The tank must be inside of the insulated box. The insulated box will be approximately 4' x 4' x width of truck.

3. The tank should be short enough so that at one end inside the insulated box can be placed the spray pump and pressure hose.

4. Facilities need to be provided for filling and draining the tank.

5. An access door should be placed at the end where the spray pump sits. This access door should access through the outside of the truck box as well.

6. A submersible heating element should be built into the tank.

7. The pressure hose should be mounted onto a reel.

8. Run an electric tape on the pressure hose and turn on only when the pressure hose is extended while spraying. Or run a small circulating tube up and back on the pressure hose. With a small circulating pump, circulate water from the main tank. This will be warm enough water to keep the pressure hose from freezing.

9. Using foam rubber pipe insulation, insulate the pressure hose.

10. Wrap the hose with poly vinyl tape or some other covering strong enough to take the abuse from dragging it around.

C. Nozzle and hose

1. The nozzle. The spray nozzle blends the water with the insulation/adhesive and directs it to the wall. Dry material flows through the hose and is directed into an oblong pattern, while the jets complete the formation of the pattern, and the insulation sticks to the surface being sprayed. The jets have a flat fan pattern. The pattern from one side may cross the pattern from the other side, depending upon whether the design of the nozzle is oblong or round shape. These will vary according to what the nozzle is designed for. A narrow or flat outlet is designed for slow, even flow used in exposed spray application. The more open the nozzle is at the outlet, the more volume it is capable of putting out. When you are spraying cavity fill Weathershield Type TA spray, use a nozzle with a large outlet opening for high volume. When spraying an exposed application with glue, use a narrow or flat shaped outlet. Nozzles sometimes have an in-line filter which should be checked with every use. If these filters get plugged, the water volume and pressure will drop, causing a drop in thrust. The material will then be too dry to stick properly to the wall. You will find an on and off valve on the nozzle. This valve turns the water on at the nozzle, but it can also fine-tune your pressure and water volume. The blower hose slides on to the inlet part of the nozzle. The hose should be free turning, because you must be able to keep your nozzle in a vertical fan pattern. Without the freedom to easily turn your nozzle on the hose, your shoulders and hands will become very tired. Take a small rasp and file away some of the inner part of the hose. Do this until the nozzle turns freely. Mark the hose with a piece of tape and always use that end of the hose as the nozzle end.

2. The hose. For spraying, it is recommended to use a 2" hose with a minimum length of 150 feet. A 2" hose is capable of spraying up to 34 (35 lb.) bags of Weathershield Type TA per hour. Most nozzles are 2", lighter in weight, easier to handle, and therefore simpler to learn to use then larger nozzles. The hose should be 2" directly off the machine. Adapting down from a larger size hose will only create a variation of flow, and fall off will occur more easily.

D. Blower machine settings. When spraying cavities, volume is one of the main goals. A good spray man spraying steadily should be able to spray 750 square feet (6" thick) per hour. Adjust air in medium range. If the slide gate is too far open, the material will not flow freely but instead will come out in clumps. Gradually close the slide-gate until the flow is even. You can do all this by placing the nozzle on the end of the hose and blowing the material into the hopper of your machine. The material should be shooting out of your nozzle about 3' before

it starts to drop. Now that you have your feed set, you may need to readjust your air. Your air pressure also affects the flow of material. If your air is too high, then you will not be able to set your flow rate properly. Adjust your air up or down to improve flow rate. You can now increase your material flow. Continue to adjust feed and air until you reach a point where where the machine has no more air to give, or the material will no longer flow evenly. Remember the material flow should shoot about 3' before dropping. The feed and air are now set correctly, and you should be able to spray at maximum blower capacity. Remember to keep all sharp bends out of your hose. Each sharp bend in the hose creates resistance and actually affects your air and feed settings.

E. Adjusting your pressure pump. After adjusting your feed and air, you now adjust your water pump. Water pumps and nozzles are so different that we can only give you some basic principles to follow. Some nozzles are designed for high water pressures and some for low pressures. Actual volume delivered at the nozzle is dependent on the number and size spray jets, pressure hose size and length, and pump pressure. We prefer to spray cavity fill spray at a pressure setting range of around 200 to 250 psi. Adjust the pump to about 200 to 250 psi and spray a small section of wall. A small hand held moisture meter may be used to determine the approximate moisture level. If the meter reads in the medium range, the water is correct for spraying cavity fill Type TA spray. After a couple of sections, use the meter again. If this proves to be acceptable, you will probably not need the meter for the rest of the job. At the end of this spray section, see a section on tracking down problems. Study and understand that section carefully, because you will need to understand all the causes of spray problems in order to run smoothly and achieve high production. But first you must learn the techniques of using the nozzle.

III. Techniques for Type TA wall cavity spray

Wall spray is a skill which must be developed. If you will learn a few basic principles, the skill will develop quickly, but a highly polished sprayer will continue to learn indefinitely.

A. Techniques for proper cavity fill.

1. Thickness. A skilled applicator will spray only 1/4" to 1/2" thicker than the stud thickness. After brushing, he will leave a very smooth surface with little on the floor to clean up. We need to consider two terms as they pertain to spraying, in order to understand how to spray at the right thickness.
Depth perception: the thickness that you perceive while you are building up the proper thickness in the wall cavity.
Optical illusion: a false sense of what you think you see. When

you spray a cavity, you will try to get proper thickness on the basis of your depth perception. You will find yourself looking at the studs to guide you, but you will find that the cavity you sprayed is far too thick. This is because the stud you were using as your guide was also gradually building up material, creating an optical illusion. If you do not understand that using the studs as guide will always steer you wrong, (because it will always create an optical illusion), you will never learn to achieve proper depth, and will waste thousands of dollars worth of material a year. To correct this illusion, you must develop the correct concept of thickness when you achieve it. In other words, develop depth perception consistent with the proper thickness, using the back side of the wall as a gauge. As in driving a car, you must learn to see more than one thing at a time. Aways see the bare wall above where you are spraying, but at the same time, see at what point the material is hitting the wall.

B. Distance from the wall. The end of the nozzle should be approximately 3 1/2' to 4 1/2' from the wall. Your air and water pressures should produce enough force to move material with proper thrust to stick at that distance. If you don't stay at that distance, you will never learn to spray smoothly. The most common mistake beginners make is in standing too close.

C. Thrust. Thrust here refers to the velocity with which the material hits the wall. This is determined by machine adjustment of air and water pressure and the distance from the wall. Correct thrust is essential to the proper density. Let's face it: if you do not achieve proper thrust, the material will drop off the wall. A good test for proper thrust exists when you can spray Weathershield Type TA into a 6" wall cavity 24" O.C. with only water, and have it stay firmly in place until dry (it will stay indefinitely if it reaches that point). You are then well on your way to success.

D. Density. Density is the ratio of the mass to its volume, or how tightly the fibers are packed together. This is determined by thrust and moisture content. Use your moisture meter to check moisture content in your wall. If you are hitting the wall with a good thrust and the moisture is correct, then your density should be within proper boundaries.

E. Nozzle motion. Your nozzle will produce a flat spray pattern which, when spraying, should usually be vertical. Start at the bottom and work up, because the material can be supported by the material beneath. Before material hits the surface of the wall, the wall must be dampened. The spray nozzle takes care of this problem automatically because the spray of the jets extends beyond the material flow, but when you start out or when you go to the next section, that section may not have the proper moisture on the surface of the wall. Solve this problem by

simply turning the nozzle horizontally, and with a sideways motion, shoot material against the back and top of the bottom plate. The moisture from the nozzle also extends beyond the sides of the material flow and will coat the wall above with moisture. This process should take only two or three seconds. Then turn your nozzle vertically and you are ready to proceed up the wall. (Some operators prefer to keep the nozzle horizontal). There are two types of motion that we would recommend that you learn.

1. The smooth sideways motion. This motion moves right to left or left to right, depending on what feels most comfortable. When completing a pass, jump back and start the next pass. If you find that you can use this method by spraying on the return pass, then this is acceptable. Each pass should overlap just enough to get an even overall appearance. You must develop this skill to the degree that you do not have to go back and touch up voids. Production and quality are the name of the game, and this skill affects both.

2. The second type of motion is one that we suggest. It has an up and down motion while also moving sideways. The advantage of this motion is that you can get better thrust and thus the material will stay in the wall more easily. The same rules apply with this method. Either jump back at the end of the pass, or use the return pass method.

F. The angle of spray. The angle of spray is an absolutely essential part of spraying and must become a habit. The proper angle is the angle directed slightly into the spray already in the wall. This means as you work up the wall, you are holding the nozzle slightly downward angling into your existing sprayed insulation. As you are moving from one side to the other, you are also angling the nozzle sideways and slightly into your existing insulation. This angle should be only about 5 . As you near the top of the wall, you do not need to hold the nozzle way up to the ceiling. However, many people have trouble with fall off (sprayed material falling out of the cavity), because they do not lift the nozzle high enough.

There are two principles to know about fall off.

1. The thicker the wall, the more weight is pulling on the sprayed insulation.

2. The wider the distance the less surface the sprayed material has to attach itself. OC (on center) is the distance from the center of one stud to the center of the next. Commonly, studs are 16" OC and 24" OC.

G. Avoid sagging. As you spray up the wall and near the top of the wall, notice when the moisture has adequately dampened the entire upper area. Move the nozzle quickly up to the bottom of the top plate, step forward and turn the nozzle horizontally. With a fast sweeping motion two or three times, coat the back corner of the wall and the bottom of the upper plate. This is done to put adequate moisture on the bottom side of the upper plate using the proper thrust to keep sagging from occurring. Sagging is a very common occurrence among inexperienced sprayer applicators. It happens within the first hour after application, and often in the first ten minutes. It has a bad appearance to contractors and homeowners and if you allow it to be a normal part of your jobs, it will affect your sales greatly. Work on this problem until you develop the skill to deal with it. After you have coated the upper plate, fill in the rest of the cavity.

IV. Recycling (Optional)

We recommend that excess material be put in the bottom of a wall cavity yet to be sprayed. Tack a 1/2" x 18" x 4' or 8' long sheet of plywood to the wall studs or hold in place with your foot. Shovel the excess material behind the plywood sheet. Use the shovel to lightly pack the material in. Remove the plywood sheet and the wall is ready to spray.

An alternate method of recycling is rerunning excess material through the machine, and respraying it. There are advantages and disadvantages to using this system, and one should seriously consider all of these before determining whether or not to recycle.

A. Advantages of recycling. The major reason for recycling is:

1. Use of all the material. This eliminates the need for disposing of the waste material.

B. Disadvantages of recycling with equipment.

1. Machine damage. Machine damage is a common occurence among applicators who recycle. It comes from running foreign objects such as nails, wood, and many other unbelievable objects through the machine. There is a simple solution to problem, but most applicators learn the hard way. The simple solution is: completely clean the entire floor of the building

before starting to spray. This does not mean just around the walls being sprayed but all of the floor. The down time experienced, is astronomical if this procedure is not observed.

2. More time consuming. Some blowers do not have the air pressure to move damp material through the hose with the thrust necessary to properly spray recycled material at the volume they could spray dry material. Recycled material needs more air pressure because of the greater resistance of damp material in the hose. Therefore, the feed setting must gradually be adjusted to less feed until (with the air as high as possible) you experience proper thrust. You must also cut water volume down. Spraying at these lower speeds means more spray time. Some machines do have the air pressure capacity to give the thrust at high volume capacity.

3. Qualified person blending. Whoever is feeding the machine must be aware of the necessity for careful blending. Inexperience may not be a disadvantage, but care in blending is critical.

C. Keep from freezing. The recycled material that will be hauled off the job to be used on the next job must not be frozen when starting the next job. Frozen material will not break up and blend with dry material.

D. Equipment (recycling)

1. Gas powered machines with agitators. These machines can hold many bags in the hopper at one time. They are good blending units. When loading the hopper, the operator should layer the wet and dry material. When the machine is operating, the material will be thoroughly blended. These large hopper machines may eliminate an extra person.

Note the chart.

2 man crew (using one bag hopper capacity not recycling)

#1 man	prep.	feed machine	clean down walls/cleanup
#2 man	set up/prep.	spray	put away equipment/cleanup

3 man crew (using one bag hopper capacity/recycling)

#1 man	prep/set up	spray	put equipment away
#2 man	prep.	feed machine	cleanup
#3 man	clean down walls		cleanup

2 man crew (using large hopper capacity/recycling)

#1 man	prep./set up	fd.mach/spray	put equip. away/cleanup
#2 man	prep.	cln dwn walls	cleanup

Large gas powered machines are not necessarily better in the air lock or with air pressure. Six or more seals are usually necessary to give smooth spray delivery. Another problem with some gas powered units is the inability to hold even R.P.M.s. Smooth delivery means no variation in R.P.M.s.

2. Electric machines. There are two types of electric machines:

   Air lock. These machines may be good volume spray units. They should contain six or more seals for smooth spray flow and should have the capacity to blow 34 (35 lb.) bags of Weathershield Type TA per hour. With the correct nozzle, one can spray at the same volume with non recycled material. Some of these machines will not recycle at that same volume, because of the lack of air capacity.

3. Fan driven. These are good machines for breaking up the material, however, they are usually low volume machines and not adequate for recycling.

E. Setting the machine for recycling.

Feed. The feed needs to be higher than when spraying dry, because material will not flow as fast.

Air pressure. This must be set for proper thrust.

Water pressure. This should be similar to dry, non-recycled pressure setting. However, the volume of water should be cut down. You do not want to add more moisture to the wall, and so you need to cut down the volume of water to compensate for the moisture existing in the recycled material being sprayed. To cut this volume down, use smaller jets on your nozzle, but retain the same pressure on your pump.

V. Particular areas to be aware of when spraying.

A. Spraying around electrical boxes. Before starting to spray in a cavity containing electrical boxes, spray behind the boxes.

B. Spraying around water (vent) pipes. Spray perpendicular to the wall on one side of the pipe, from the bottom to the top. Then fill in the other size with the nozzle at a side angle of approximately 60°.

C. Rim joists. In a two story house, a crawl space, or wherever a wood floor exists, there is a border upon which the floor joists are fastened. This is called a rim joist. These rim joists must always be insulated because they are just as much a part of the wall as any other area. Rim joists should be sprayed too, but

before spraying, reset the machine. We would recommend spraying the rim joists before you start the walls. In setting the machine for rim joists, cut the feed to about 9 bags per hour. Air and water pressures may be set similar to the walls. Remember that air and water pressures should be strong while feed must be slow. The areas that run parallel to the floor joists are much harder, and care should be taken to thoroughly insulate these areas. Because there is not much room to get the correct angle in these area, we would recommend that you:

1. Dampen the place where you will start.

2. Start from the top just as if you were spraying the upper plate, and with the nozzle horizontal, spray the section using the same motion as used in spraying the upper plate of wall cavity fill. With some practise you will be able to completely cover the joists. Make sure you have sprayed on at least 2".

D. <u>Sprayed staggered studs.</u> This is done much the same way as around pipes. One should be sprayed perpendicular to the wall. The other side should be sprayed at a 60 angle in order to completely fill behind the stud. There will always be more material on the floor while spraying staggered studs than straight walls.

E. <u>Spraying around pressure pipes (cold and hot water lines).</u> These are sprayed the same way as a regular wall section except that these pipes contain water under continuous pressure. The heated side of the pipe must be cleaned off. That will allow the heat from the building to keep the pipe from freezing. Freezable pipes should not be wrapped, but instead should be insulated only on the outer side of the pipe. The inside should be left open so it can be exposed to the heat.

F. <u>Spraying around pipes in rim joists.</u> Spray around pipes in rim joists the same as if they were in a wall cavity. Just remember to clean off the spray on the heated side of the pipe after spraying. Don't forget: this can be a very expensive mistake.

G. <u>Around showers and tubs.</u> Showers are sometimes against the outside wall. Many contractors will insulate behind these areas before they set the shower. You can save them work and give them a well insulated wall area behind that shower by dry filling the space to the top of the shower, and spraying the remainder of the open wall to the plate. This will help to retain the heat in the shower. If you choose, spray the open sides of the shower (outside) for better sound control. If you are working around tubs, fill around and under with your recycling material. This will insulate these areas and keep the water hot much longer.

VI. Adhesives.

In an exposed application adhesives are absolutely necessary. In wall cavity fill, a liquid adhesive is not necessary. Our company mixes a dry adhesive in while manufacturing the product. This improves the products ability to adhere to the wall while spraying and after drying will produce a more cohesive mat, with adhesion to sheathing, studs and plates.

VII. Sound control with spray.

Spraying wall cavities for sound control is excellent. Increase your profits by spraying walls around bathrooms, bedrooms, offices, utility rooms, furnace rooms and any other areas where sound control could be helpful. The thickness should be 1" to 1 1/2". This will give a Sound Transmission Classification (STC) rating within a medium range in a single wall and a high level of sound control in a staggered wall.

VIII. Party walls (sound walls between apartments or condominiums).

These should be treated similarly to other sound walls except that we suggest spraying 1 1/2" inches. If you choose to fill the wall, do not spray so wet that water runs out onto the floor after cleanup. You may want to try a couple of sections and clean up around them. Allow it to set out for a few minutes to see if water is seeping out onto the floor. If only dampness is occurring, there should not be a problem. If water is running out, remove those sections and start again.

IX. Spraying crawl spaces.

There are many ideas on how to insulate crawl spaces. Insulating the floor is an accepted method in many areas. However, we do not agree with those who feel this is the best method for crawl spaces. We have found that when a floor is insulated, the disadvantages greatly outweigh the advantages:

1. Insulating the floor lowers the temperature of the crawl space.
2. This colder temperature will conduct through the joists and keep the floor cold.
3. Pipes are in more danger of freezing when the crawl space temperature is lowered.
4. If one attempts to spray the floor, there is not enough room in most crawl spaces to spray. Four feet of clearance is needed from the end of the nozzle to the surface being sprayed.

Spraying the perimeters on the inside, from the base of the footings up to and including the rim joists, has proven to be the best and most effective method of insulating crawl spaces. A common response to the

question: "Have you noticed a difference in your house since the crawl space was insulated?" has been, "Yes, the floor is so much warmer, and we don't feel drafts on our feet." Approximately two inches should be sufficient to give a proper thermal performance (an insulated layer that stops conduction).

A. Machine settings.

FEED	- Set at approximately 10 bags per hour.
AIR PRESSURE	- Use more air pressure than when spraying wall cavities.
WATER PRESSURE	- Use 250 to 300 psi.
WATER VOLUME	- More than with wall cavities (use larger jets).
THRUST	- Hard thrust against the surface of the wall.
DENSITY	- Much higher density than when spraying wall cavities.

B. Crawl space for profits. Spraying crawl spaces is an excellent method for high profits. It will usually take only one or two hours to insulate. The square footage is low compared to the floor footage, and a crew of two (or even one with a large hopper machine) can do the job. At the end of the job there is no cleanup.

X. Basements - Furred out Walls

Basements can be furred out with 2 x 4's or even 2 x 6's and sprayed. Spraying is a good method to insulate furred areas. You will spray this with the same procedure as in all other cavity wet spray applications.

B. Factors to keep in mind.

1. Concrete soaks up moisture; therefore use more water volume on concrete.

2. Clean carefully along the bottom edge if there is not a horizontal strip, or you will break away the material from the wall.

XI. Equipment for cleaning up.

A. Wall brush. This equipment is a must for cleaning down walls. It is a motorized spinning brush designed especially for brushing sprayed walls. It cuts the excess off sprayed walls and leaves a completely smooth finish with studs left completely free of sprayed material. This tool will sell many future jobs. Remember to run the wall brush all of the way to the floor. Alternatively, a 4' length of 1" x 4" board may be used to screed the surface.

B. Bagger. This is a metal frame made to hold plastic insulated bags open. One person with a bagger and a snow shovel can clean the excess off the floor quickly. It, too, is a necessity to save time on the job.

C. Snow shovel. We recommend a flat snow shovel because in dumping the material in the bag, you can simply lift the shovel over the bagger and turn it sideways. The Weathershield Type TA will slide off easily. A scoop shovel must be lifted high into the air and faced downward in order for the material to slide off into the bagger. This is harder work and more time consuming.

D. Plastic bags. We package Weathershield Type TA plastic bags. These are tough bags and very good for clean up. When you open the bags, open one end only, and dump it out into the machine. You now have the best clean up bag money can buy. Give the extra to the contractors; they will love them.

E. Tapered broom. Use a standard straw broom. Cut approximately 3" off the end of the broom at an angle. Bevel both edges. Cut a point on the end of the handle to clean out corners at the top of the wall. Use the broom for all corners, around windows, doors, trusses on the stud face around electric boxes, and in fact anywhere sprayed material must be removed after brushing, except the floor.

F. Floor cleaning broom. We would recommend an angled nylon broom. These will leave floors clean and are especially good in corners. Push brooms usually will not clean Weathershield Type TA very easily off of floors.

G. How clean is clean? To please your customers and build your future clientele, leave your jobs spotless. Yes, we said SPOTLESS. This is done for one reason only. To impress the contractor or homeowner and convince him that you are a professional. You have been taught in a professional manner; now be a professional. Your reputation will sell your jobs. Why pay a sales person to get repeat customers. A professional job will automatically bring them back for you.

XII. Tracking down problems.

We can only suggest various causes for the problems that arise. You must follow the spray instructions carefully and you will not have to refer to this section often. One of the common problems is:

A. Fall off. This is the most common problem, and the hardest to trace. Machine settings are the most common fault, technique is next. Go through this check list:

1. Thrust. Do you have the feed and air settings such that when the water is off, the material will travel straight out to about 3' to 4' before falling?

2. Does your water gauge show correct moisture levels in the walls?

3. Is your water pressure high enough to provide the thrust against the wall (200 - 250 psi)?

4. Are you standing 3 1/2' to 4 1/2' away from the wall? If you have low thrust, you can correct this by moving one foot closer.

5. Is the filter to the nozzle partially restricted or are the jets plugged? Even with your gauge reading properly, your water volume can be reduced considerably with plugged filters.

6 Is there enough air pressure? Use your air gauge on your blowing machine outlet to see if your seals are working properly. Watch for pulsation which will mean a bent blade or a bad seal in the air lock chamber.

7. If your water pump is not performing properly, check for worn seals or leaking diapragm.

B. Sagging.

1. Did you turn the nozzle to get a horizontal pattern and then with two or three quick passes, coat the back corner of the upper plate? Timing on this is so important. Learn how to get the most solid packing effect possible to eliminate this problem.

2. Did you step up to drive the material harder into the corner of the upper plate?

3. Are you getting proper thrust or is your air pressure setting too low?

4. Has your nozzle built up material inside the outlet end, which is hindering proper flow?

5. Too much water can also result from too much pressure or too large of jets.

C. Material being pulled off with the brush. This is caused by low density, which usually means that it was sprayed too dry. The two areas to check are moisture and thrust.

D. Voids show up after brushing. You need to spray smoother and thick enough to build all sprayed material beyond studs. With proper thickness these voids and water marks will not exist.

E. Uneven surface when sprayed. Study the section on technique.

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